US LHC Accelerator Research Program

brookhaven - fermilab - berkeley

Accelerator Physics & Beam Commissioning

With vital contributions from W. Fischer,
M. Furman, T. Markiewicz, F. Pilat, T. Sen, ...

What are the DRAFT plans for FY04 (and FY05)?

(How sensible will these lists look in 12 months time?)

Accelerator Systems "BASELINE" budget

		FY04	FY05	FY06	FY07	FY08	FY09
Labor Count	FTE	2.6	7.1	14.6	18.0	17.2	15.4
Labor Cost	$k03	502	1314	2410	2910	2676	2380
Travel	$k03	27	74	146	185	169	154
Materials & Services	$k03	90	330	760	865	690	690
TOTAL COSTS (escalated)							
Instrumentation	$k	300	744	1,733	2,048	1,953	1,897
Beam Comm & Acc Phys	$k	227	570	1,366	1,896	1,895	1,952
Hardware Commissioning	$k	111	509	525	512	249	0
GRAND TOTAL	**$k**	**638**	**1,823**	**3,623**	**4,457**	**4,098**	**3,850**
Guideline	$k	635	1,820	3,620	4,460	4,100	3,840

Instrumentation – "baseline is prolog"

		FY04	FY05	FY06	FY07	FY08	FY09
Labor count							
Tune feedback	FTE	.5	.5	1.6	1.8	1.0	.0
Luminosity monitor	FTE	.6	1.4	2.4	1.8	1.0	.0
Longitudinal density monitor	FTE		.5	1.6	2.5	2.4	1.0
Additional Instrumentation	FTE				.4	2.3	4.9
Materials & Services							
Tune feedback	$k03	40	70	180	180	50	0
Luminosity monitor	$k03	40	150	300	250	100	0
Longitudinal density monitor	$k03		40	200	300	200	50
Additional Instrumentation	$k03				70	300	600
Labor cost	$k03	202	424	860	960	976	880
Travel	$k03	10	17	46	60	59	59
Materials & Services	$k03	80	260	680	800	650	650
TOTAL COST							
Constant dollars	$k03	292	701	1,586	1,820	1,685	1,589
With 3.0%/year escalation	$k	300	744	1,733	2,048	1,953	1,897

Initial Instrumentation

"We should integrate Accelerator Physics and Instrumentation Physics activities, as far as possible"

Need to establish "Task Sheets"

1) Tune and Chromaticity Feedback

- separate studies at BNL & FNAL for 2 years, then make a technology choice
- multiple oscillators?
- control room cognoscenti assert that this will be a critical commissioning and (early) operational tool ...

How much lumi without chromaticity feedback?

(W. Fischer) Very rough estimate

- Pilot bunch: $5 \cdot 10^9$ p [P. Collier, Chamonix XII]
- Allowable loss at injection or snapback: $5 \cdot 10^{10}$ p [10 times loss allowance at store]
- No chromaticity feedback: chromaticity snapback may be ~20 units (non-reproducible 20% part of ~100 units)
- ξ~20 leads to ~10% beam loss [~Tevatron experience]
- $\rightarrow$ 100 pilot bunches can be accelerated through snapback, or 5 nominal bunches
- $\rightarrow$ **Luminosity ~ 10^{31} cm^{-2}s^{-1}** (5 nominal bunches/ring)
  $\rightarrow$ **Luminosity ~$5 \cdot 10^{29}$ cm^{-2}s^{-1}** (100 pilot bunches)

Initial Instrumentation

2) Luminosity Monitor

- build eight 4-channel devices in FY2005-2006

- 40 Mhz demonstration is essential in FY04, eg for technology choice (CdTe)

- evaluate compatibility with ZDC lumimonitors

Initial Instrumentation

3) Longitudinal Density Monitoring

1) Abort Gap Monitor

- simple, robust, dedicated, reliable
- critical (even early) for Machine Protection System

2) Optical Sampling System

- very powerful and sexy as a tool to study longitudinal beam dynamics, eg tomography, diffusion, ...
- state-of-the-art, complex, multi-purpose

Are these 2 devices “one and the same”?
Review by Machine Protection Committee?

Beam Commissioning

TI8 test with beam	Sept	2004 !
Commissioning sector 7-8	May	2005
Injection test with beam	April	2006
TI2 commissioning	April	2007
LHC commissioning	April	2007 ->

Consistent with this schedule – NOW (FY04) - establish WHAT "1 US physicist on every control room shift" means, and HOW to do it ....

Commissioning – topics

What we can offer in the transfer line and injection beam tests?

If LARP becomes responsible for a problem/topic, we must have the resources and committments to do so. It would be a failure if CERN took over a problem assigned to LARP.

With CERN, establish which commissioning problems are sufficiently covered, and which are not.

Avoid covering a problem twice, or not covering it at all!

Commissioning – people

Associate responsibilities with people. Define a list of people?

Responsibilities will be quite different from person to person.

Some (eg those intimately involved in instrumentation development) have a natural project, others may not.

Define one or more principal CERN contacts (cf Oliver Bruning)

Maybe one contact for all of us, or one for each of us, or one for some of us and ....

Commissioning – controls

"This is just the right moment to influence the design of the LHC control system"

- to allow remote collaboration
- make LHC data/database available in real time
- define LARP analysis and applications

Suggest tools that are vital at other machines

- sequencer, ramp management, on-line modeling, databasing, LogView, SDA, ...

Questions of firewalls and bandwidth have to be addressed.

Remote Operation test beam experiments at RHIC & FNAL?

Commissioning

May want to offer a package for Turn-By-Turn BPM data analysis – the level of CERN interest must be established.

Hadron Collider Commissioning Workshop (in early discussions)

- LARP "is a stakeholder" in any scenario, but
- the broader the workshop scope, the less useful it will be

Interaction regions – optics

Feasibility of upgrade options with divergent axes quadrupoles

Prioritize upgrade scenarios on the basis of known LHC limitations (dispersion suppression, matching section)

Determine minimum space needed between IR separation dipoles (input needed from Magnet program)

Determine minumum space needed between IR quadrupoles with parallel axes (input from Magnet)

Defer field quality requirement discussion for IR options to 2005+

Need an IR Optics workshop?

Interaction regions – correction

Conceptual design for different IR upgrade options

Develop operational IR correction techniques (pre-upgrade)

Non-linear correction system testing at RHIC

Test driving term compensation scheme for LHC IR corrections (as implemented in an LHC simulation package)

Test of beta star tuning knobs developed at CERN for the LHC. RHIC beam experiment?

Measurement techniques for non-linear and skew chromaticity, dynamic aperture (BNL, FNAL)

Electron cloud

SPS simulations

- reproduce measured electron energy spectrum & spatial distribution
- reproduce calorimeter results
- POSINST vs ECLOUD: understand and iron out differences
- Calibrate MAP method for electron cloud density and flux (BNL)

Obtain better data for **secondary emission yield and emission spectrum for actual beam screen samples**

- Desirable to reach Eo < 20eV (important and hard to measure)

Electron cloud

Obtain better data for **quantum efficiency and photon reflectivity for actual copper samples**

Simulate the **effects of EC on beam**

Assess EC density **diagnostics using microwaves** (?)

Beam-Beam

Bench-mark and validate strong-strong codes

Beam-beam compensation with electron lens and possibly wires

Coherent mode observation and suppression - crossing angles?

Measurement of beam-beam resonance driving terms

Effect of bunch length and crossing angles on 1) lifetime 2) background, 3) tunes, 4) sweeping lumimonitor

Emittance growth, background, stability of collisions with transverse offsets

Energy deposition and collimation

Study magnet designs for different upgrade IR layouts

Study performance of LHC machine protection system

Material damage testing for phase 1 LHC collimators? (SLAC)

Measure short and long range wakefields of Phase I collimators? (SLAC)

Consumable Collimators

SLAC has developed a consumable collimator for the NLC collimation system, allowing a finite number of damage events before the collimator needs to be replaced.

The nominal LHC Phase I system is not expected to survive Phase II abort kicker misfires (25 ns bunch spacing, L = 1e34).

A modified NLC consumable collimator probably would survive

An R&D project could deliver a tested prototype and drawing package by the end of 2007.

This project seems to be a natural fit to the LARP

Acknowledgements

Sincere thanks to all the participants, plus

David McChesney
Diana Votruba
Ila Campbell
Mary Campbell
Linda Roberts &
the Danfords staff


US
LARP